FORTRAN II
FOR THE
RAYTHEON 250 COMPUTER

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FORTRAN

The most widely used computer compiler language is called FORTRAN, an abbreviation of FORmula TRANslation. FORTRAN compilers have been made available for many types of digital computers, both large and small. FORTRAN is an *algebraic compiler* since many of the statements allowable in the FORTRAN language closely resemble ordinary algebraic formulas. Other compiler languages, COBOL, for example are designed primarily for business and commercial applications rather than scientific and engineering calculations.

One of the main advantages of FORTRAN is that it is easy to learn. With relatively brief training and practice, a scientist or engineer can acquire sufficient fluency in FORTRAN to program his simpler computing problems and to understand and assist with more complicated programs written in FORTRAN by programming specialists.

FORTRAN is not only a language in which a human speaks to a computer; one of its most important uses is to enable scientists, engineers, and programmers to talk to *each other* about computers and computations.

RAYTHEON 250 FORTRAN II

The development of FORTRAN II for the Raytheon 250 Computer represents a major advancement in software for small scale computers. The Raytheon version of FORTRAN is similar to the earlier versions of the FORTRAN language. An example of the operating efficiency of Raytheon 250 FORTRAN II is the implementation of the inversion of a matrix. The processor will compile the inversion of a 10 x 10 matrix in approximately 40 minutes. The object program will execute in less than 7 minutes. These times include input/output. A Raytheon 250 equipped with 3856 words of memory is capable of compiling and running a 14 x 14 matrix inversion.

The only limitations imposed upon a FORTRAN program by the new compiler are those connected with the hardware capabilities of the Raytheon 250 itself. For instance, a program that requires more storage locations than are available in the Raytheon 250, or which calls for non-existent peripheral equipment, will not compile a working machine-language program for the Raytheon 250.

In addition to the following brief description of Raytheon 250 FORTRAN II, a more detailed manual is also available. A knowledge of FORTRAN by the reader is assumed. However, for those who wish more information on FORTRAN, the references listed at the end of this bulletin may be helpful.

I. CONSTANTS, VARIABLES, SUBSCRIPTS AND EXPRESSIONS

1. Constants

Raytheon 250 FORTRAN II allows fixed and floating constants written in accordance with the usual conventions.

Fixed Point: 1 to 7 digits without a decimal point, with an optional preceding + or − sign.

Floating Point: 1 to 10 digit mantissa with a decimal point, with an optional preceding + or − sign. If an exponent is specified, the decimal point may be omitted but will be assumed to the right of the low order digit of the mantissa. The exponent (absolute value less than or equal to 38) is separated from the preceding mantissa by the letter E and consists of an optional sign and a 1 or 2 digit representation of the exponent magnitude.

2. Variables

Variables are identified by a name beginning with a letter and are composed of letters and/or digits. A name may be longer than 7 characters, but only the first 7 are used in the determination of uniqueness. The last character of a variable's name must not be the letter F.

There are two kinds of variables:

—Fixed Point (name beginning with I, J, K, L, M or N)

—Floating Point (name beginning with a letter other than those used to designate fixed point)

3. Subscripting

An element of an array may be represented by a variable modified by 1, 2 or 3 subscripts. The subscript designation follows the array name and is enclosed in parentheses. Individ-

ual subscripts are separated from each other by commas and may consist of any integer or floating point expression.

The storage assignment of an array is such that the first subscript varies most rapidly, then the second, and finally the third, so that a two-dimensional matrix is ordered row by column. The storage order is such that the highest address is associated with the first term of an array, with decreasing addresses for subsequent terms.

4. Arithmetic Expressions

The following signs are used in arithmetic expressions:

+	addition
−	subtraction
*	multiplication
/	division
**	exponentiation

Operator hierarchy conforms to the normal FORTRAN rules.

Functions are normally indicated by an F as the last letter of the identifying name.

Fixed and floating point variables may be arbitrarily mixed in a Raytheon 250 FORTRAN II arithmetic expression although such a capability is normally available in FORTRAN II only in a restricted sense.

II. FUNCTIONS, SUB ROUTINES

Raytheon 250 FORTRAN II allows both subroutines and functions. The following functions are available.

SINF	Sine
COSF	Cosine
LOGF	Natural logarithm
TANF	Tangent
SQRTF	Square root
ATANF	Arc tangent
EXPF	e^x
ABSF	Absolute value
INTF	Integer
FLOATF	Float
FIXF	Fix

All these functions may be used at will in fixed or floating point expressions (without prior use of FLOATF for conversion).

III. LIST OF RAYTHEON 250 FORTRAN II STATEMENTS

arithmetic expressions of the form A = B

GO TO stat
GO TO stat, (stat 1, stat 2, . . . , stat m)
ASSIGN stat 1 to stat m
GO TO (stat 1, stat 2, . . . , stat m)
IF (expr), stat 1, stat 2, stat 3
SENSE LIGHT n
IF (SENSE LIGHT n) stat 1, stat 2
IF (SENSE SWITCH n) stat 1, stat 2
PAUSE n
STOP n
DO stat ind = n_1, n_2 or n_1, n_2, n_3
CONTINUE
END
CALL name (arg 1, arg 2, . . . , arg n)
SUBROUTINE name (arg 1, arg 2, . . , arg n)
FUNCTION name (arg 1, arg 2, . . . , arg n)
RETURN
READ (list)
PUNCH
PRINT
COMMON
DIMENSION

IV. SYNTAX OF RAYTHEON 250 FORTRAN II STATEMENTS

The syntax is the same as for normal FORTRAN, except for the following statements:

COMMON: This statement appears at the front of a program (or function or subroutine). The only statements which may precede it are:
FUNCTION
SUBROUTINE
DIMENSION

READ: Format specification is not necessary because input is in the form of paper tape.

Following the READ and enclosed in parentheses is the list of the names of the variables whose values are to be read. Names in the list are separated by commas. The read statement works for ordinary or subscripted variables but not for arrays. To read an array the programmer must write the appropriate DO loops.

PRINT or PUNCH:

The syntax for these two statements is the same. The format specifications, being easy to express, are part of the output list of variables. A list element of a PRINT or PUNCH statement conforms to the following syntax:
Output in fixed point format of a floating point variable:

name [h, character, x, y]
x. number of digits before the decimal point
y: number of digits after
h: up to 30 hollerith characters

Output in floating point format of a floating point variable:

name [h, character, 0, x]
x: number of digits in the mantissa
h: up to 30 hollerith characters

Output in fixed point of a fixed point variable:

name [h, character, y, 0]
y: number of digits
h: up to 30 hollerith characters

"Name" is intended to represent an ordinary or subscripted variable. "Character" designates the position where the user may specify any character that he wishes to have appear immediately after the value of the variable. (If the character chosen is a decimal point, however, a carriage return will be given.)

The PRINT statement results in the following:
hollerith (if any), value, character

The PUNCH statement causes punching of only the value and the specified character.

V. REPRESENTATION OF RAYTHEON 250 FORTRAN II PROGRAM

Statement key words must be written in upper case.

Names must be written in lower case.

The codes for space, error, tabulation, and delete are ignored.

The carriage return code indicates the end of a FORTRAN statement. (If the statement is longer than a line, the punch must be turned off to achieve a carriage return without punching the carriage return code in the tape.)

Comments, enclosed by quotation marks, may be written between statements.

VI. THE COMPILATION PROCESS

A compilation occurs in two passes.

1. Reading of the FORTRAN source program, assignment of addresses and possible error message detection. The source program is read entirely. As the work progresses, a punched tape in an intermediate language is punched.
2. If the first pass has not resulted in an error halt, the second pass may be initiated by the loading of the tape prepared during the first pass.

   Second pass tape reading occurs block by block (256 words) with a compilation time of 8 to 10 seconds between blocks. The compiled program is punched onto tape.

   FORTRAN functions and subroutines are compiled separately. They must be compiled each time they are used with a main program.

VII EQUIPMENT

Minimum configuration:

Raytheon 250 Computer with "Execute from A Register" command.

Input/Output: Flexowriter

Optional Equipment for Faster Compilation:

ETC-8 (8-switch box)
HSR-1 (fast reader)

REFERENCES

1. McCracken, Daniel D., *A Guide to Fortran Programming*, Wiley and Sons, New York, 1961.
2. *FORTRAN Infograph*, Celestron Associates, Inc., Valhalla, New York.

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